North Atlantic Treaty Organization
Research and Technology Agency
HFM-180/RTC Technical Course
Strategies to Address Recruiting and Retention Issues in the Military

USING INCENTIVES TO ALIGN INDIVIDUAL CHOICE WITH ORGANIZATIONAL OBJECTIVES U.S. NAVY RESEARCH INITIATIVES AND APPLICATIONS

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Incentive Experiments

- Objective: Gain an understanding of pecuniary and non-pecuniary incentives that can influence the alignment of individual choice with organizational objectives
- 4 sets of experiments
  - Multi-attribute Auction
    - » Precursor to Assignment Incentive Pay (AIP)
  - Cafeteria Style Compensation
  - Risk Preference Elicitation and Non-cognitive Metrics
  - Resource Allocation Experiments
  - Pending: Personal Discount Rate Experiments

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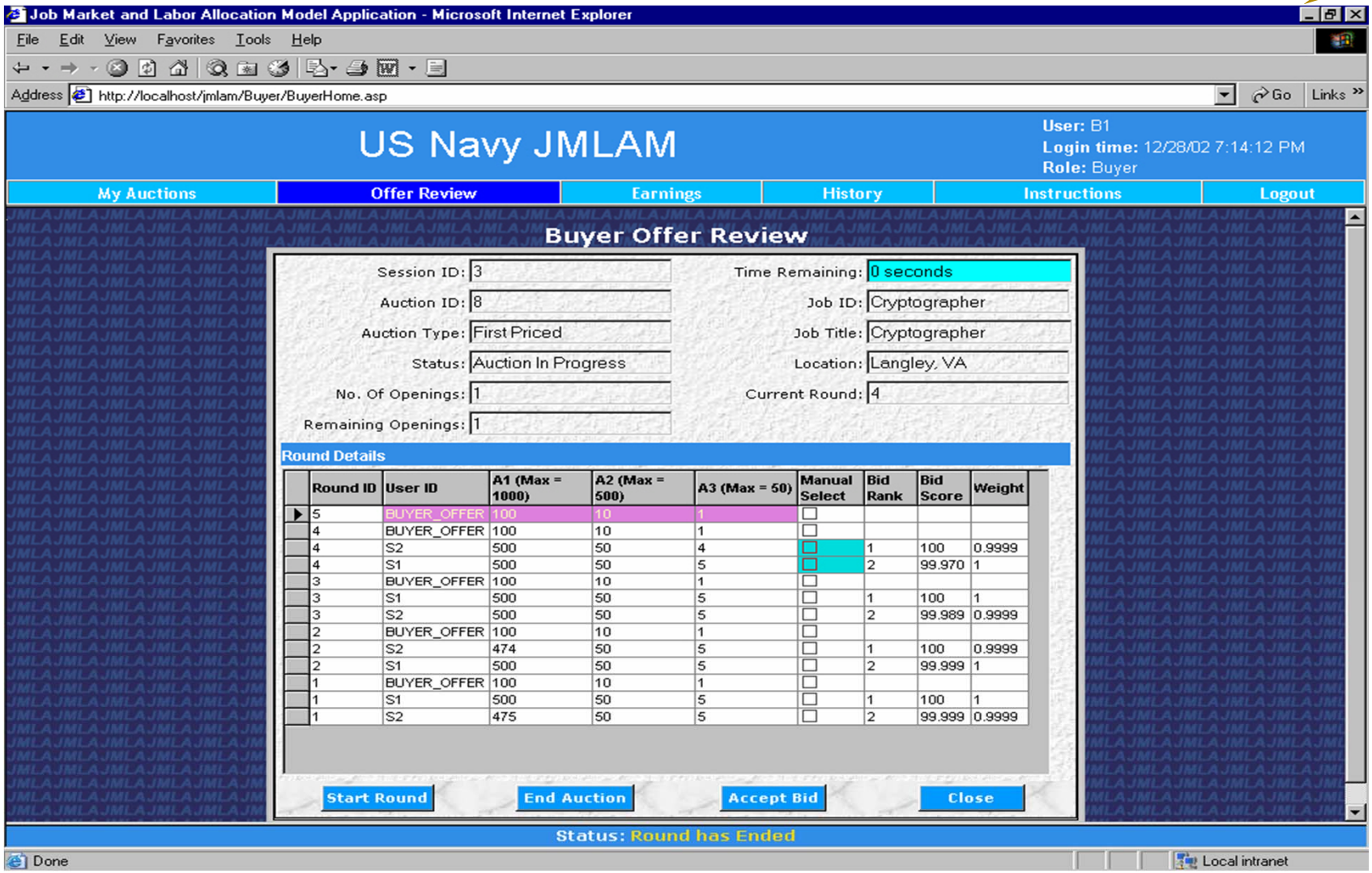
Multi-Attribute Auctions

Multi-attribute Auction



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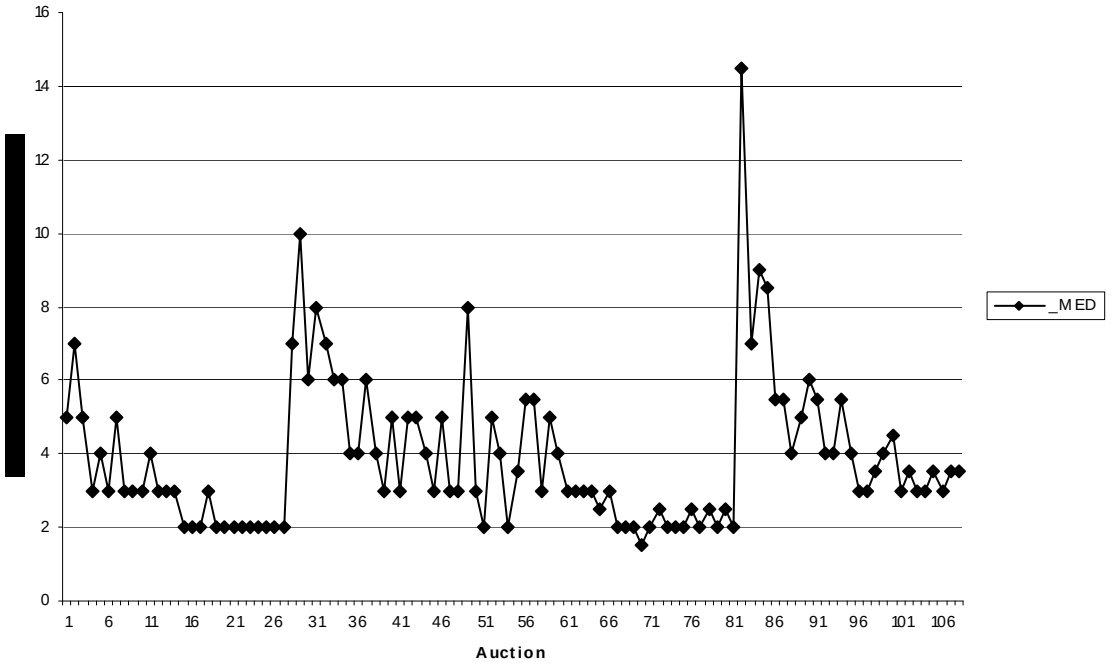
Auction: Experimental Design

Table 2
Experiment 2 parameters

	.6, .8 or 1, randomly assigned session/auction/subject
Seller Value	
Reserve Prices (A1, A2, A3)	(13, 10, 6) if seller value = .6
Reserve Prices (A1, A2, A3)	(16, 12, 8) if seller value = .8
Reserve Prices (A1, A2, A3)	(20, 15, 10) if seller value = 1
Job Openings	2, unknown to the seller
Seconds for Play	60 seconds
Conversion Rate	.10, $1 Experimental Dollar = $0.10 USD
Maximum Number of Rounds	10, unknown to seller
Buyer Reserve (A1, A2, A3)	(100, 50, 25), unknown to the seller
Maximum Number of Sellers	9, average subjects per session was 7

- Individual bid on attributes of a job or components of a compensation package.
- Forced market convergence – jobs must be filled.
- Seller value is a reflection of the sellers marginal cost or' marginal productivity.

Median Bids Converge to Reserve



Results: Experiment 2 Median Difference of Composite Bid

Discrete Choice Experiments

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Cafeteria Style Compensation Packages

- Current compensation is fixed
- Explore feasibility of offering a menu of cash and non-cash benefits such that total employer set compensation level is not exceeded.
  - 'Choice' promotes increased job satisfaction
    - » Leads to increased retention
- Critics of flexible compensation plans site:
  - High administration costs
  - Too many choices led to sub-optimal choices, leading to job dissatisfaction.
    - » Focus: Can individuals make optimal choices over multiple and discrete options – equivalent to compensation plan with multiple attributes.

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Experimental Sessions

Experimental Treatment Constant Across Sessions							
	Cell Values						
Matrix Dimensions	Lower Bound	Upper Bound	Cell Weight	Value Limit	Revocable Moves?	Seconds per round	Conversion Rate
5x5	100	1000	1.2	2000	Yes	240	0.001

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Experimental Sessions

Table 1. Experimental Parameters

I. Parameters varied across sessions	Session S1	Session S2	Session S3	Session S4
Cell Payoff per round	20	100	20	100
Fixed Payoff per round [a]	80%	80%	50%	50%
Number of Rounds	9	8	10	11
Fixed Deduction (US$)	$17.00	$18.00	$20.00	$27.00

II. Parameters constant across sessions

Matrix Size	Cell Value Range	Cell Weight	Value Limit	Revocable Moves?	Seconds per Round	Conversion Rate (E$ to US$)
5 × 5	100–1000	1.2	2000	Yes	240	0.001

[a] As a percentage of maximum possible earnings from playing the cell selection game.

The Use and Effectiveness of Heuristics

Six Heuristics

H_S. Select the highest remaining cell value until the value limit prohibits further selection.

H_A. Select three cells that (nearly) exhaust the value limit, focusing on cell values in the 800-1000 range, but also selecting outside this range

M_S. Select four cells in the 400-699 range that (nearly) exhausts the value limit.

M_A. Select five cells that (nearly) exhaust the value limit, focusing on cell values in the 400-699 range, but also selecting outside this range.

L_S. Select the lowest remaining cell value until the value limit prohibits further selection.

L_A. Select six or more cells that (nearly) exhaust the value limit, focusing on cells in the 100-399 range, but also selecting outside this range

Experimental Model

- The subject's reward from selecting *k* cells is the sum of the rewards from each of the cells that s/he selects.

Subject maximizes:

$$(1a) \quad \sum_{i=1}^{k} [\text{Cell Payoff} + (\text{Cell Weight} \times \text{Cell Value}_i)]$$

rearranging

$$(1b) \quad k \times \text{Cell Payoff} + [\text{Cell Weight} \times \sum_{i=1}^{k} \text{Cell Value}_i]$$

Subject to

$$(2) \quad \sum_{i=1}^{k} \text{Cell Value}_i \leq \text{Value Limit}$$

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Categorization of Subject Heuristics

Categorization of Subject Heuristics from the Data

Heuristic	Across Sessions	By Individual Session			
		S1	S2	S3	S4
High Numbers (chooses 3 cells or less)	5% (4/80)	10% (8/80)	10% (8/80)	14% (11/80)	9% (7/80)
Medium Numbers (chooses 4 or 5 cells)	16% (13/80)	26% (21/80)	28% (22/80)	25% (20/80)	29% (22/80)
Low Numbers (chooses 6 or more cells)	51% (41/80)	61% (49/80)	61% (49/80)	60% (48/80)	63% (50/80)
Mixed (uses multiple strategies)	28% (22/80)	n/a	n/a	n/a	n/a
Unable to Categorize	n/a	3% (2/80)	1% (1/80)	1% (1/80)	1% (1/80)
Column Total	100% (80/80)	100% (80/80)	100% (80/80)	100% (80/80)	100% (80/80)

Note: Subjects who receive the High, Medium or Low designation in the Across Sessions column are identified as using that heuristic in each of the four sessions. Of the 23 subjects who use the Mixed strategy, 6 use a combination of Low/Medium, 13 use Medium/High, 2 use Low/High, and 1 uses Low/Medium/High. In the Unable to Categorize row, the subjects who could not be categorized were different in each session, i.e., these are five separate subjects. See text and Appendix 4).

Heuristics

Rewards to Heuristics as a Percent of the Maximum Possible Reward						
Session	Simple Heuristics				Advanced Heuristics	
	High H_S	Middle M_S	Low L_S		High H_A	Middle M_A	Low L_A
S1	90.8%	97.2%	88.8%		96.4%	98.1%	99.7%
S2	80.0%	89.9%	92.8%		86.6%	93.1%	99.9%
S3	90.9%	97.6%	92.1%		96.6%	93.1%	99.9%
S4	79.1%	88.4%	99.8%		85.2%	91.5%	99.8%
Column Average	85.5%	93.3%	93.4%		91.2%	95.3%	99.8%

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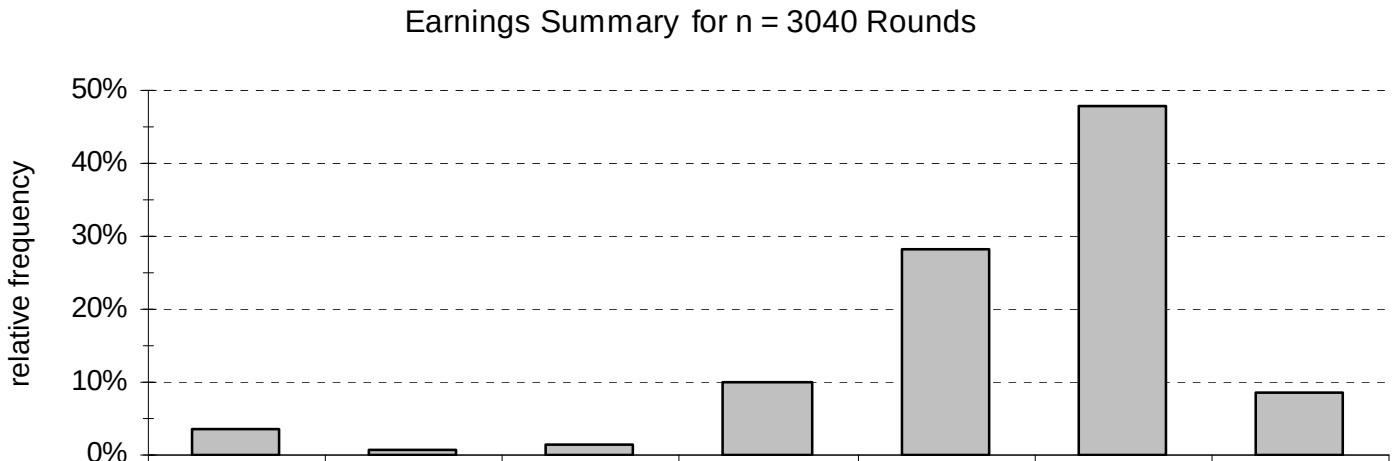
Results



	chose fixed payoff	earned 0% (timed out)	earned less than 80%	earned 80 - 89%	earned 90 - 96%	earned 97 - 99%	earned 100%
number	107	23	41	299	855	1451	264
frequency	3.5%	0.8%	1.3%	9.8%	28.1%	47.7%	8.7%

Note: Earnings expressed as percentage of maximum possible reward

1. Four minute constraint not binding
2. Subjects opt to play the game
3. When subject opt to play game majority earn > 97% of potential

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Fixed Effects Regression Model

Fixed Effects Model:

$$Y = \beta_0 + \beta_F \text{Fixed} + \beta_T \text{Timeout} + \sum_{i=2}^{4} \beta_{Si} \text{Session}_i + \sum_{j=2}^{11} \beta_{Rj} \text{Round}_j + \sum_{k=2}^{80} \beta_{Subk} \text{Subject}_k + \varepsilon$$

Question: How well does the subject perform relative to the optimal solution?

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Model Variables

Variable	Definition
Dependent Y	
Earnings Ratio	Subject's per-round earnings, as a percent of the maximum possible in the round
Cell Ratio	Number of cells in subject's final per-round choice, as a percent of the number of cells in the round's optimal solution
Search Ratio	Total number of cells subject selects per round (including those not part of subject's final choice), as a ratio of the number of cells in subject's final choice for the round
Fixed	= 1 if subject chooses the fixed payoff option in the round = 0 otherwise
Timeout	= 1 if time expires before subject is finished in the round = 0 otherwise
Session $_i$ $i = 2, \ldots, 4$	= 1 if Y observation from session S*i* = 0 otherwise
Round $_j$ $j = 2, \ldots, 11$	= 1 if Y observation from round R*j* = 0 otherwise
Subject $_k$ $k = 2, \ldots, 80$	= 1 if Y observation from subject Sub*k* = 0 otherwise

Note: There are n = 3040 observations of each dependent variable. There are 107 instances where Fixed = 1 and 23 instances where Timeout = 1.

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Hypotheses Tests

Hypotheses Tests from Fixed Effects Regressions

Test	Dependent Variable: Earnings Ratio	Dependent Variable: Cell Ratio	Dependent Variable: Search Ratio
	$R^2_{Adj} = 0.85$	$R^2_{Adj} = 0.77$	$R^2_{Adj} = 0.49$
Overall Model H_0: $\beta_{S2} = \ldots = \beta_{Sub80} = 0$	F = 196.9 p < .001	F = 111.2 p < .001	F = 29.7 p < .001
Session Effect H_0: $\beta_{S2} = \beta_{S3} = \beta_{S4} = 0$	F = 174.0 p < .001	F = 5.07 p = .002	F = 2.19 p = .087
Round Effect H_0: $\beta_{R2} = \ldots = \beta_{R11} = 0$	F = 1.24 p = .260	F = 4.37 p < .001	F = 2.13 p = .020
Subject Effect H_0: $\beta_{Sub2} = \ldots = \beta_{Sub80} = 0$	F = 28.1 p < .001	F = 70.9 p < .001	F = 13.6 p < .001

Note: n = 3040 for each regression. See Appendix 3 for further detail.

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Conclusions

- Two main results
  - Relative tradeoff between the attributes is a significant treatment variable.
    - » Subject payoffs higher if variable attribute given relatively more weight.
    - » Majority of subjects adopt heuristics to approximate optimal solution
  - Subjects rarely choose fixed payoff, even when fixed payoff is 80% of potential variable payoff
    - » Suggests individuals place a high value on flexibility and choice.
    - » Suggests individuals confident in their ability to reach an optimal choice.
    - » Given complex choice environment individuals have the capacity to approximate nearly an optimal solution.
- Support for 'choice' in compensation packages
  - Suggests Policymakers should focus on introducing 'choice' into Military institution…possible positive implications for job satisfaction and tenure (retention/recruiting).

Risk Preference Experiments

Risk Preference, Personality, and Cognitive Ability

- Risk preference
  - Individual choices affect market, organizational, or financial outcomes
  - Economic theory is silent on “why” individuals exhibit a particular risk preference
- Hypothesis: There will be statistical relationships between risk preference, cognitive, and non-cognitive factors
- Alignment of individual choice and organizational objectives
  - Predict individual choice
  - Aggregation of individual choices influences organizational outcomes
    - » Example: If we observe correlation between risk seeking and Adventuresome facet, are these individuals more likely to exhibit a particular job choice—SEALS, pilots, submariners
      - – Tailor job options to preferences
      - – Tailor compensation packages

Risk Preference: Experimental Design

- Series of paper-and-pencil questionnaires, N = 193 subjects
  - Risk preference elicitation game (Holt & Laury, 2002)
    - » Series of gambles over differing payout probabilities
  - Trust measure
  - Demographic information
  - International Personality Item Pool – facet level items
  - Subject pool
    - » University Students – 1st generation college
      - – 18-24 years old, smaller sample 30+
- Subjects paid for participation
  - $5 show up fee
  - $17 for completion of demographic, personality questionnaires
  - $3-$8 for risk preference game
  - Average time to completion 30-40 minutes

Preferences Toward Risk

- Expected Utility – sum of the utilities associated with all possible outcomes, weighted by the probability that each outcome will occur.
- Risk Seeking – prefers an uncertain income to a certain one, even if the expected value of the uncertain income is less than that of the certain income.
  - E(u)=.5u($10) + .5u($30) > u($20)
- Risk Neutral – indifferent between a certain income and a certain income with the same expected value.
  - E(u)=.5u($10) + .5u($30) = u($20)
  - Risk Averse – preferring a certain income to a risky income with the same expected value.
  - E(u)=.5u($10) + .5u($30) < u($20)

Demographics

Gender	
Female	31%
Male	69%
N=	193

Race	
African American	22%
Asian	18%
Caucasian	53%
Hispanic	4%
Other/Missing	3%

Grade Point Average	
>1.9	1%
2.0-2.9	40%
3.0-3.4	24%
>3.5	21%
Missing	14%

Age	
17-19	19%
20-22	54%
23-25	19%
26-29	4%
>30	3%
Missing	1%

Risk Preference by Gender

	Risk Seeking	Risk Neutral	Risk Averse	Risk Mixed
Female	23.7%	44.1%	8.5%	23.7%
Male	25.4%	44.0%	8.2%	25.4%

Note: 59 Females, 134 Males; row percent sums = 100%

Risk Preference by Race

Race	Risk Seeking	Risk Neutral	Risk Averse	Risk Mixed
African American, N = 43	6.21%	7.77%	1.04%	7.25%
Asian N = 34	4.14%	5.18%	.52%	7.77%
Caucasian N = 103	12.43%	27.46%	4.66%	8.81%
Hispanic N = 7	1.55%	1.55%	0%	.52%
Other/Missing N = 6	0%	1.55%	0%	.52%

Risk Preference Distribution

Relative Risk Preference	Count (N = 193)	Percentage
Risk Loving	57	29.5
Slightly Risk Loving	32	16.6
Risk Neutral	45	23.3
Slightly Risk Averse	40	20.7
Risk Averse	9	4.7
Very Risk Averse	5	2.6
Extremely Risk Averse	5	2.6

Regression Results

- Model 1a Dependent variable: Relative Risk Preference
- Model 1b Dependent variable: Risk Preference
  - Independent variables: GPA, gender, race, neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness
- Model 2 Dependent variable – Risk Preference
  - Independent variables: GPA, gender, race, adventurousness, vulnerability, excitement seeking, assertiveness, cautiousness, trust
- Results: Race, assertiveness significant

Risk Preference and Personality Measures – Specific Facets

Risk Seeking and Risk Averse Observations

Neuroticism: Immoderation	F(1,57)=4.77	MSE = 7.1	p<.05	r=-.28
Extraversion: Excitement-seeking	F(1,57)=.6	MSE=373.6	p<.45	r=-.10
Openness: Imagination	F(1,57)=3.01	MSE=657.2	p<.09	r=-.22
Agreeableness: Trust	F(1,57)=.78	MSE=454.0	p<.38	r=-.12
Conscientiousness: Cautiousness	F(1,57)=5.04	MSE=14.3	p<.03	r= .29

Ho: Risk Seeking – Risk Averse = 0, where Risk Averse is base case comparison

Risk-seekers are less cautious, more impulsive, and somewhat more imaginative than risk-avoiders

Conclusions

- Berg, Dickhaut, & McCabe (PNAS, March 2005) shows risk preference instability across institutions – may explain low correlations
- Small sample problems
  - Expand relative risk categorization, but need larger sample
- Risk Mixed Strategy – 33% initial, reduced to > 9%
- Some evidence of relationship between personality and risk preference/present value of money
  - With given sample limited inference as to relationship between personality, cognitive ability and risk preference
  - Coding intelligent agents
  - Code for personality and risk preference
- Next Steps
  - Expand sample to include 30+ years
  - Modify experiments to ascertain correlation of time, value of money, personality and cognitive ability
    - » Test to see if we can infer discount rate
      - – Pecuniary and non-pecuniary compensation components
    - » Helps us set value of incentive packages offered

Resource Allocation Experiments

Resource Allocation Experiments-Efficiency Gains of Resource Assignments

- Examines Heterogeneity of billets
  - We think of billet heterogeneity as location, job function, tasks, training requirements, promotion potential
    - » Experimental Domain can capture job heterogeneity by:
      - – Imposing utility value at individual level
      - – Varying command budget
    - » Observe differences in bargaining and convergence of person-job matches
- Individual choice
  - Asymmetric information, variability in compensation offers, cost of job search or refusing offer
- Command offers
  - Budget to be allocated, payoffs, quality constraints, affect on offers when resources is are free/not free
- Institutional constraints/rules
  - Asymmetric/full information, repeated bargaining, constrained resource allocation by quality type, allowable gaps vs no-gaps

Incentives: Assignment Game

Objective: heterogeneity of the billets and the decision to quit conditioned on market information and expected payoffs

Table 1 – Example Treatment Conditions for Assignment Game

Number	Treatment Condition	Treatment Values
1	Information Concerning Assignment Values	Common Private
2	Payoffs to Proposer and Responder	Certain Uncertain
3	Responders	2 3
4	Repeated Game	Yes No
5	Number of Rounds	Known Unknown
6	Rejection Costs	Symmetric Asymmetric
7	Responder Offers Prior to Billet Assignment	No (baseline) Yes (BEACON)

Assignment Game: Treatments and Results – No Information Setting

Treatment Conditions	Average amount offered by AO (% of budget)	Average amount paid by AO (% of budget)	Readiness by Ship % of Ships	Readiness by Battle Group	Average cost of filling all billets
Baseline	98.76 (3.21) [80]	96.67 (7.67) [80]	91.25 (3.18) [80]		153.68 (3.60) [73]
Share of Savings	69.22 (8.55) [100]	64.39 (15.30) [100]	79.00 (4.09) [100]		130.90 (6.82) [79]
Tournament Bonus (40)	59.77 (7.10) [80]	52.72 (16.94) [80]	72.50 (5.02) [80]		126.29 (16.99) [58]
Share of Savings plus Tournament Bonus (40)	59.58 (6.03) [80]	53.50 (14.02) [80]	68.75 (5.21) [80]		140.52 (22.16) [55]

Discount Rates

Pending Research: Individual Discount Rates (IDR) Experiment

- Objective: To estimate individual discount rates.
- Exponential vs. Hyperbolic discount rate formulations
  - Exponential – assumes discount rate is constant over time.
  - Hyperbolic – captures inconsistency over time preference of money. Discount rate varies over time.
- Map discount rates, with risk preference and non-cognitive metrics.
- Experimental design intended to inform individual preferences over various pecuniary incentives.
- Improve discount rate estimates in Retention-SRB models, enlistment bonus models, and Montgomery GI Bill.

Questions?

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